PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant	:	KENJI YAMAMURA ET AL.	
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APPEAL BRIEF UNDER 37 C.F.R. §1.192

This appeal brief is submitted in triplicate and is accompanied by a check in the amount of $330.00 in payment of the appeal brief fee. This response is timely by virtue of a petition for a one-month extension of time concurrently filed, along with the requisite fee. If the check becomes detached, or if there is any deficiency, please charge any required fee to the Deposit Account 05-1323 (CAM # 038921.48531US).

This is an appeal from the February 27, 2003 final rejection of Claims 1-4 and 11 in the above-captioned application.

Real Party in Interest

This application is assigned to NSK Ltd. of Tokyo, Japan, which is the real party in interest in this appeal.

Related Appeals and Interferences

Applicants and their counsel are not aware of any related appeals or interferences which would affect, be affected by, or have a bearing on the instant appeal.

Status of Claims

Claims 1-4 and 11 are pending. Claims 1-4 and 11 are finally rejected and form the subject of this appeal.

Status of Amendments

There are no unentered amendments.

Summary of Invention

As discussed in the Background Art section of the present application, bearings used in the spindles of magnetic disk drives require both high rotational accuracy and long contact fatigue life. To increase rotational accuracy, it is advantageous to reduce residual austenite as much as possible, preferably to zero by volume. A common method of reducing residual austenite is to <u>increase</u> tempering temperature. To increase contact fatigue life, on the other hand, it is advantageous to increase surface hardness. A common method of increasing surface hardness is to <u>reduce</u> the tempering temperature. Therefore, the requirements of high rotational accuracy and long contact fatigue life make contradictory demands on tempering temperature. The question then is whether a tempering temperature can be found that satisfies both rotational accuracy and contact fatigue life requirements.

It is believed in prior art that, with an inexpensive and workable steel material, it is impossible to find a tempering temperature that can satisfy both requirements for a bearing used in the spindles of a magnetic disk drive. At the minimum tempering temperature required to reduce the residual austenite to zero by volume, the surface hardness would be too low (e.g., less than HRC 62).

In prior art, similar problems are solved by (1) using a sufficiently high tempering temperature to reduce the residual austenite to zero by volume and (2) using a surface hardening treatment such as carburization to increase surface hardness. However, surface hardening treatment is difficult to apply to the thin inner and outer rings of small bearings, such as the ones used in the spindles of magnetic disk drives (see the specification, page 3, lines 19-24).

Applicants discovered a steel material that can satisfy the contradictory demands on tempering temperature without using surface hardening treatment. This steel material contains alloying ingredients within the ranges of C: 0.8 to 1.20% by weight, Si: 0.60% by weight or less, Mn: 0.25% by weight or less, Cr: 1.00 to 1.50% by weight and Mo: 0.60 to 1.50% by weight (see Claims 1-4 and 11). With this steel material, a tempering temperature can be found that reduces residual austenite to zero by volume and also maintains surface hardness at HRC 62 or higher (see Claims 1-4 and 11).

Applicants also discovered that if a rolling element contains less carbon, more Mn and less oxygen, and is applied with carbo-nitridation (see Claims 2 and 11), the level of vibration at high rotational speeds is reduced, and the acoustic life is also improved.

Additionally, Applicants discovered that if a rolling element is made from a martensitic stainless steel, applied with nitridation to form a nitride surface layer of 3 μm or more, and then finished to surface roughness of 0.1 μm Ra or less (see Claim 3), further advantages can be achieved as set forth in the specification at page 3, lines 1 to 10.

Furthermore, Applicants discovered that if a rolling element is made from a ceramic material, impact resistance of the bearing is improved (see Claim 4).

Rejections

1. Claims 1, 2, 4 and 11 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Matsumoto et al. (U.S. Patent 5, 122,000) in view of Mitamura (U.S. Patent 5,626,974), and further in view of Murakami et al. (U.S. Patent 5,352,303).

2. Claim 3 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Matsumoto et al. in view of Mitamura, and further in view of Murakami et al., as applied to Claims 1, 2, 4 and 11, and further in view of Tanaka et al. (U.S. Patent 6,086,686).

Issues

The issues on appeal are as follows:

1. Whether Matsumoto et al. discloses a single steel species having the alloy ingredient ranges of Claims 1-4 and 11 when it discloses only discrete ingredient values from several steel species but not a single steel species having the alloy ingredient ranges of Claims 1-4 and 11;

2. Whether the rejections of Applicants' invention as obvious are proper when Applicants' invention achieves unexpected results and its critical ranges are not specifically disclosed by the references cited in the rejections; and

3. Whether the rejection of Claims 1, 2, 4, and 11 as obvious is proper when the references cited in the rejection do not teach or suggest the claimed limitation that retained austenite is 0% by volume over the entire cross section and the claimed limitation that the surface hardness of the raceway is HRC of 62 or more.

Grouping of Claims

For the purpose of this appeal, Claims 1, 2, 4, and 11 stand or fall together.

Argument

I. Summary

Applicants submit that the rejections of Claims 1-4 and 11 as obvious are improper for at least the following three reasons.

First, contrary to the Examiner's contention, the primary reference, Matsumoto et al., does not disclose the ranges of alloy ingredients specified by Claims 1-4 and 11.

Second, Applicants' invention achieves unexpected results, and the invention's ranges of alloy ingredients are not specifically disclosed by the cited references.

Finally, the references cited in the rejections do not teach or suggest the claimed limitation that retained austenite is 0% by volume over the entire cross section and the claimed limitation that the surface hardness of the raceway is HRC of 62 or more.

II. Matsumoto et al. does not disclose the ranges of alloy ingredients specified by Claims 1-4 and 11

Applicants submit that Matsumoto et al. does not disclose the ranges of alloy ingredients specified by Claims 1-4 and 11. As explained in detail hereinafter, contrary to the Examiner's contentions, Table 1 of Matsumoto et al. does not disclose a single steel species that contains alloy ingredients within the ranges of 0.2 to 1.23 wt% C, 0.4 wt% or less Si, and 1 wt% and 2 wt% Cr. Additionally and more specifically, it is improper to conclude that Table 1 of Matsumoto et al. discloses the range of C: 0.2 to 1.23% when Table 1 discloses only several discrete C values within that range.

Background

As described above in Summary of Invention, Applicants discovered a steel material that can satisfy the contradictory demands on tempering temperature without using surface hardening treatment. This steel material contains alloying ingredients within the ranges of C: 0.8 to 1.20% by weight, Si: 0.60% by weight or less, Mn: 0.25% by weight or less, Cr: 1.00 to 1.50% by weight and Mo: 0.60 to 1.50% by weight (see Claims 1-4 and 11). With this steel material, a tempering temperature can be found that reduces the residual austenite to zero by volume and, at the same time, maintains the surface hardness at HRC 62 or higher.

The invention described in the primary reference, Matsumoto et al., is very different from Applicants' invention. First, Applicants and Matsumoto et al. were concerned with different types of bearings which operate under very different conditions. Specifically, while Applicants were concerned with improving the fatigue life and rotational accuracy of very small rolling bearings operating at very high rotating speeds,

Matsumoto et al. is concerned with relatively low speed, large rolling bearings (column 2, lines 13-22) used in automobiles, agricultural machines, construction machines, and iron and steel machinery (column 1, lines 6-8). Consequently, while the bearing race surfaces of Applicants' invention cannot be hardened with surface hardening treatment, surface hardening treatment can be applied, and is indeed applied, to bearing race surfaces in Matsumoto et al. (column 5, lines 3-15).

Additionally, because of the very different operating conditions, the requirements on surface hardness and residual austenite are different as well. While Applicants had to reduce the residual austenite to zero by volume and maintain the surface hardness at HRC 62 or higher, Matsumoto et al. was only faced with the requirements of less than 10% average residual austenite by volume (column 2, lines 54-56) and varied surface hardness requirement (column 2, lines 27-32).

Furthermore, Applicants and Matsumoto et al. used very different approaches to achieve their objectives. Applicants relied on a combination of alloy ingredients that allows the use of <u>low tempering temperature</u> to achieve both zero residual austenite by volume and surface hardness at HRC 62 or higher. In contrast, Matsumoto et al. uses one method to reduce residual austenite and uses a different method to improve surface hardness. Specifically, Matsumoto et al. uses <u>high tempering temperature</u> to reduce residual austenite (column 5, lines 16-23) and reduces <u>the size of carbides</u> to improve surface hardness (column 5, lines 20-23).

To ensure that the carbides are less than 6 μm in diameter (column 6, lines 11-50), Matsumoto et al. uses a mathematical formula (see the bottom of column 6) to determine the proper alloy ingredients. In Example 1 (column 6, line 65 to column 7, line 67), Matsumoto et al. demonstrated that alloy ingredients (Table 1) selected in

accordance with the mathematical formula can ensure that there are no carbides having a diameter of 6 μm or larger (Table 2).

In the Office Actions dated Nov. 7, 2000, June 12, 2001 and Feb. 20, 2002, the Examiner rejected the pending claims as obvious. The Examiner contended that Matsumoto et al. discloses a single steel that contains five alloy ingredients: 0.2 to 1.23 wt% C, 0.4 wt% or less Si, 2.0 wt% or less Mn, 1 wt% and 2 wt% Cr, and 2.0wt% or less Mo. In particular, the Examiner contended that Table 1 of Matsumoto et al. discloses a single steel species that contains three of the five alloy ingredients, namely, 0.2 to 1.23 wt% C, 0.4 wt% or less Si, and 1 wt% and 2 wt% Cr.

In the response filed on July 22, 2002, Applicants argued that Table 1 of Matsumoto et al. does not disclose this alleged single steel species. In fact, Applicants showed that no single steel species in Table 1 has alloy ingredients that are within, or even close to, the ranges of Claims 1-4 and 11. Applicants further showed that no single steel species in Table 1 satisfies both the Cr and C ranges of Claims 1-4 and 11. Applicants pointed out, as an example, that only steel species A and M in Table 1 have a Cr content that is within, or even close to, the Cr range of Claims 1-4 and 11, but the C content (0.21%) of species A and M is not even close to the C range (0.8 to 1.2%) of Claims 1-4 and 11. In fact, Applicants pointed out that none of the steel species in Table 1 have a C content that is within the C range (0.8 to 1.2%) of Claims 1-4 and 11.

Applicants stated that Table 1 of Matsumoto et al. merely discloses 14 steel species (A-N) that have various combinations of alloy ingredients. Because no single steel species in Table 1 has alloy ingredients that are even close to all the ranges of Claims 1-4 and 11, Applicants pointed out that the Examiner had to selectively pick the

ingredient contents of several steel species to conclude that a single steel species discloses the alleged ranges used in the rejections of Applicants' application.

Applicants argued that, for at least two reasons, the Examiner's selective picking of the ingredient contents of several steel species is improper. First, Applicants pointed out that the Examiner concluded that Table 1 discloses a range of C: 0.2 to 1.23%, based on the fact that Table 1 discloses one steel species (B) having C = 0.2% and a different steel species (K) having C = 1.23%. According to Applicants, it is improper to conclude that the range of 0.8 to 1.2% is disclosed by two separate points (0.2% and 1.23%) located outside of the claimed range (0.8 to 1.2%) by alleging that the two separate points (0.2% and 1.23%) disclose a range (0.2% to 1.23%).

Second, Applicants pointed out that it is improper to select the content of one ingredient from one steel species and the content of another ingredient from a different steel species to conclude that a single steel species discloses both ingredients and their contents, because this would lead to a clearly erroneous conclusion that a material having 20% of ingredient A and 20% of ingredient B is anticipated by two materials, one of which has 20% of ingredient A, and the other has 20% of ingredient B.

In the next Office Action dated Oct. 2, 2002, the Examiner did not address Applicants' arguments. Instead, the Examiner stated that Applicants' arguments were moot in view of new grounds of rejection (see the bottom of page 6 of the Office Action). However, the Examiner's "new" rejections still relied on the contention that Table 1 of Matsumoto et al. discloses a single steel material containing alloy ingredients of 0.2 to 1.23 wt% C, 0.4 wt% or less Si, and 1 wt% and 2 wt% Cr (see the bottom of page 2 of the Office Action). In fact, the Examiner has never addressed Applicants' arguments.

Table 1 of Matsumoto et al. does not disclose a single steel species that contains alloy ingredients within the ranges of 0.2 to 1.23 wt% C, 0.4 wt% or less Si, and 1 wt% and 2 wt% Cr.

In the obviousness rejections, the Examiner contended that Table 1 of Matsumoto et al. discloses a single steel species that contains alloy ingredients of 0.2 to 1.23 wt% C, 0.4 wt% or less Si, and 1 wt% and 2 wt% Cr.

Applicants submit that Table 1 of Matsumoto et al. does not disclose a single steel species containing alloy ingredients that are within the ranges of 0.2 to 1.23 wt% C, 0.4 wt% or less Si, and 1 wt% and 2 wt% Cr. In fact, no single steel species in Table 1 has alloy ingredients that are within, or even close to, the ranges of Claims 1-4 and 11. With respect to the claimed range of C (0.8% to 1.20%), for example, none of the 14 steel species have a C content that is within the claimed range (0.8% to 1.20%). The C values of species J and K (0.73% and 1.23% respectively) are the closest to the claimed range of C (0.8% to 1.20%). However, the Cr values of species J and K (12.94 % and 13.10% respectively) are far above the claimed Cr range (1.0% to 1.5%).

With regard to the Cr value, only steel species A and M in Table 1 have Cr values (1.03% and 2.01% respectively) that are within, or even close to, the Cr range of Claims 1-4 and 11 (1.0-1.5%). However, the C value (0.21%) of species A and M is not even close to the C range (0.8 to 1.2%) specified by Claims 1-4 and 11.

Because no single steel species in Table 1 has alloy ingredients that are even close to all the ranges of Claims 1-4 and 11, the Examiner had to select the content of one ingredient from one steel species and the content of another ingredient from another steel species to arrive at the alleged ranges of ingredients used in the rejections of

Applicants' application. For example, the C range (0.2 to 1.23 %) of the alleged single steel species is based on a single C value (0.21) from species A and another single C value (1.23%) from species K. The alleged range of Cr (1 to 2 %) is based on a single Cr value (1.03%) from species A and another single Cr value (2.01%) from species M.

Applicants submit that this selective picking of ranges of ingredients from different steel species is improper because it would lead to a clearly erroneous conclusion that a single material having 20% of ingredient A and 20% of ingredient B is disclosed by two materials, one of which has 20% of ingredient A, and the other has 20% of ingredient B.

In addition, the Examiner's selective picking of ranges from several different steel species to arrive at the ranges of Applicants' invention can only come about with hindsight provided by Applicants' disclosure. Without the hindsight provided by Applicants' disclosure, one with ordinary skill in the art would not have contemplated the Examiner's specific selection of ranges from different steel species. Such hindsight rejection of Applicants' invention is not permitted under patent law.

Because it is improper to conclude that Table 1 of Matsumoto et al. discloses <u>a single steel species</u> containing alloy ingredients within the ranges of Claims 1-4 and 11 when the alloy ingredients actually belong to several steel species, Applicants respectfully request reversal of the rejections of Claims 1-4 and 11.

It is improper to conclude that Table 1 of Matsumoto et al. discloses the range of C: 0.2 to 1.23% when Table 1 discloses only several discrete C contents within that range

In the obviousness rejections, the Examiner contended that Table 1 discloses a range of C: 0.2 to 1.23%. However, an examination of Table 1 shows that it merely

discloses several discrete values of C between 0.2 to 1.23%. The Examiner provided no legal authority that supports the proposition that a reference discloses a range (0.2 to 1.23%) if it discloses several points within the range.

Moreover, none of the C values of Table 1 are within the C range (0.8% to 1.20%) of Claims 1-4 and 11. In effect, the Examiner concluded that the C range (0.8% to 1.20%) of Claims 1-4 and 11 is disclosed by discrete C values that are below or above the range (0.8% to 1.20%) but are not within the range.

Applicants submit that the Examiner's conclusion is improper because it would lead to the clearly erroneous conclusion that a material having 50% of an ingredient is anticipated by two materials, one of which has 1% of the ingredient, and the other has 99% of the ingredient, on the ground that the combination of the two materials discloses a range of 1-99% of the ingredient.

Accordingly, Applicants respectfully request reversal of the rejections of Claims 1-4 and 11.

III. <u>The cited references cannot render the claimed invention obvious because the claimed invention achieves unexpected results and because the claimed invention's critical ranges are not specifically disclosed by the cited references</u>

In prior art, it was not expected that low temperature tempering alone can reduce the residual austenite to zero by volume and also maintain the surface hardness at HRC 62 or higher. In this respect, as discussed above, Matsumoto et al. is no different from the prior art (see, for example, the first full paragraph of column 5). Because Applicants' invention achieves this unexpected result and because, as discussed

above, its critical ranges are not specifically disclosed by the cited references, it cannot be rendered obvious by the cited references (see MPEP, 2144.05, III, first paragraph).

It appears that none of the steel species disclosed by Matsumoto et al. can achieve this result. For example, Matsumoto et al. teaches that "high temperature tempering (450-600°C) is more preferred than low temperature tempering (for example, at 160-200°C), because the retained austenite can be transformed into a martensite..." (see column 5, the first full paragraph). In other words, Matsumoto et al. teaches that low temperature tempering cannot eliminate austenite. This indicates that Matsumoto et al. did not realize that it is possible to reduce austenite to 0% with low temperature tempering. Therefore, the bearing materials of Matsumoto et al. appear to have the same problem associated with the prior art bearing materials, as discussed in the background section of Applicants' application. This is not surprising as, as discussed above, none of the steel species disclosed by Matsumoto et al. have alloy ingredients that are even close to the ranges specified by Claims 1-4 and 11.

Moreover, Applicants wishes to add that since Applicants' invention achieves unexpected results and since the art of metallurgical technology is extremely unpredictable, it is highly improper to predicate the alleged disclosure of multiple ingredient ranges of a single steel species on the discrete ingredient values of several steel species. For example, a steel material having 20% of ingredient A and 20% of ingredient B can have properties that are very different from those of a material having 20% of ingredient A and from those of a material having 20% of ingredient B. Further, it is also highly improper to predicate the alleged disclosure of a range on two discrete values outside the range. For example, a steel material having ingredient A in the

range of 20 to 30% can have properties that are very different from those of a material having 15% of ingredient A and from those of a material having 35% of ingredient A.

Accordingly, Applicants respectfully request reversal of the rejections of Claims 1-4 and 11.

VI. The references cited in the rejections do not teach or suggest the claimed limitation that retained austenite is 0% by volume over the entire cross section and the claimed limitation that the surface hardness of the raceway is HRC of 62 or more

Comments on the cited references

Matsumoto et al. Matsumoto teaches that rolling bearing dimensional stability is improved when the average concentration of retained austenite is lower, and requires that the average concentration of retained austenite be less than 10% so that the dimensional stability of the rolling bearing of the claimed invention is equivalent to or superior to that of the bearing steel SUJ-2.

However, Matsumoto et al. actually discloses that the minimum average of retained austenite is 6.4 (see Table 7) and retained austenite on the surface is 20% vol or more and retained austenite in the core portion is 5% vol or less as (see the amount distribution of retained austenite in Fig. 9).

Mitamura. Mitamura discloses a rolling bearing for use in industrial machines under high temperature conditions, typically at 130°C or higher. The rolling bearing includes an inner ring, an outer ring and a plurality of rolling elements which are made of a high carbon steel and have a hardness of HRC 60 or higher.

The high carbon steel includes a solid solution of carbon C and a solid solution of nitrogen N which are adjusted to satisfy $0.8\text{wt\%} < C < 1.2\text{wt\%}$ and $0.1\text{wt\%} < N < 0.5\text{wt\%}$, in order to allow hardening at a reasonable temperature and to improve bearing endurance.

The retained austenite in every part of the bearing is adjusted to 0 vol% by tempering at the temperature of 270 to 300°C, in order to improve dimensional stability.

The main feature of Mitamura's invention is that, considering the decomposition of retained austenite on the surface, the bearing must be subjected to tempering at 270°C or more after carbonitriding and hardening in order to reduce retained austenite to 0 vol%. As a result, bearing endurance is significantly affected by the contents of solid solution of carbon C and solid solution of nitrogen N.

However, Mitamura only discloses that the steel is SUJ-2, and this steel does not contain Mo.

Moreover, it is clear from Table 1 of Mitamura that the hardness of Run Nos. A (minimum) and C (maximum) are 61.4 and 61.8 respectively, and they are lower than HRC 62 specified Applicants' invention.

Murakami et al. Murakami et al. discloses a rolling bearing which has good rolling fatigue properties for use in automotive transmissions. The rolling bearing includes an inner ring, an outer ring and rolling elements which are made of an alloy steel. The alloy steel is subjected to carbonitriding at 820°C, hardening and tempering at 180°C, so that the total content (C+N) of C and N in the surface layer is 1.0 to 2.0 wt%, and the ratio N/C is 0.8 to 2.0.

As a result, the rolling bearing is improved not only in rolling fatigue life but also in wear resistance, in seizure resistance, and in tempering resistance.

However, Murakami et al. does not disclose the amount of the retained austenite at all.

<u>Tanaka et al.</u> In the latest Office Action, the Examiner cited the third embodiment of Tanaka et al. (column 12, lines 22 to 26, and lines 40 to 43). The rolling bearing has a plurality of members each comprising an outer race, an inner race or a shaft element. At least one of the rolling members has secondary hardenability and a nitride layer of 2% or less along the diameter D_a of a rolling element in a surface layer of a finished article.

The nitride layer comprises a Cr nitride layer and an Fe nitride layer, and is nitrided at a temperature of 480°C or lower. Addition of such a nitride layer to the bearing material can prevent adhesion, decrease friction and significantly improve fretting damage.

Further, the steel of Tanaka et al. contains C: 0.45 wt% or less, N: 0.05 wt%, Cr: 12.0 to 13.5 wt%, Mn: 0.1 to 0.8 wt%, Si: 0.1 to 1.0 wt%, Mo: optionally 0.3 wt% or less and C+N is 0.5 wt% or more.

The above steel was hardened at a temperature of 1020 to 1070°C and then secondarily hardened at 450°C for 2 hours. Next, a nitride layer with a depth of about 20 μm was formed as a surface layer by gas nitriding at 410°C for 24 hours.

Table 8 shows that the surface roughness after nitriding is 0.18 Raμm.

However, in Tanaka et al., there is no disclosure of the subject matter of the raceway ring at all.

The differences between the cited references and Claims 1, 2, 4 and 11

Claims 1, 2, 4, and 11 versus Matsumoto et al., Mitamura, and Murakami et al. A common subject matter of Claims 1, 2, 4, and 11 is that one of an inner ring and an outer ring is formed of a steel which is subjected to hardening and tempering, and the amount of residual austenite over its entire cross section is set to 0% by volume and the surface hardness is set to HRC 62 or more.

With regard to Matsumoto et al., the bearing steel is made based on the assumption that it would be subjected to carburization and has carbides of 6 mm or less at the depth of 2% D_a.

Since carburization treatment is a precondition, the base carbon of the steel species in Table 1 is low and the content of C wt% on the surface is higher than that in the core portion.

Since retained austenite increases as C increases, as shown in Fig. 9 of Matsumoto et al., retained austenite on the surface, which has a higher C content, exceeds 20 vol% while retained austenite in the core portion, which has low C content, is less than 5 vol%.

Therefore, it is clear that in Matsumoto et al. there is no disclosure of setting retained austenite over the entire cross section to 0 vol% at all.

Regarding dimensional stability, as shown in Fig. 9 of Matsumoto et al., even if there is much more retained austenite (Vol%) on the surface, if the average retained

austenite is less, dimensional change of the whole raceway ring accompanying the martensitic transformation of retained austenite will become smaller.

However, with respect to impact resistance, since impact force is applied to the raceway surface of the raceway ring, it is obvious that the raceway surface can be easily damaged when the raceway surface is soft due to high retained austenite content.

That is, although a low value of total retained austenite vol% is enough for dimensional stability, it is very important for impact resistance to set retained austenite on the raceway surface to 0 vol%. In Applicants' invention, retained austenite is 0 Vol% over entire cross section and at least on the surface.

Therefore, even if Matsumoto et al. considered dimensional stability, they did not consider impact resistance.

With regard to Mitamura, since the steel of Mitamura is made using carbonitriding, surface solid solution of nitrogen, and tempering at 270 to 300°C, it does not have the improved tempering resistance of Applicants' invention due to the added Mo.

Although both Mo and C+N increase tempering resistance, the hardening hardness before tempering is high for Mo.

If Mo is added in advance to the material, since a martensitic transformation is promoted during quenching to improve hardenability, hardness after quenching is higher.

On the other hand, the quenching hardness after adding C+N will be almost saturated if C+N exceeds 0.8% wt%, and the increase of this value will result in

increased amount of retained austenite vol%. However, it will reduce hardness, resulting in less impact resistance.

Accordingly, not only for reduction in heat treatment cost, but also for surface hardness after tempering, Mo is advantageous over C+N.

This is why the surface hardness in Table 1 of Mitamura ranges from a minimum of HRC 61.4 to a maximum of HRC 61.8.

With regard to Murakami et al., the steel of Murakami et al. is made by means of carbonitriding, and fine carbides form on the surface of the rolling member. Murakami et al., however, does not teach that retained austenite is 0 vol%.

Tempering resistance is improved by performing solid solution of Mo and Cr in the martensitic structure, which is a matrix. It is not accomplished by consuming these two elements as carbides, as described in Murakami et al.

Therefore, Murakami et al. does not disclose the features of the claimed invention that retained austenite over the entire cross section is 0 vol% and, at the same time, surface hardness is HRC 62 or more.

Because Matsumoto et al., Mitamura and Murakami et al. do not disclose or suggest that retained austenite is 0% by volume over the entire cross section and the surface hardness of the raceway is HRC of 62 or more, it is not obvious to combine Matsumoto et al., Mitamura and Murakami et al. to arrive at Applicants' invention, and Applicants respectfully request reversal of the rejections of Claims 1, 2, 4, and 11.

V. Conclusion

For the foregoing reasons, the rejections of Claims 1-4 and 11 under 35 U.S.C. §103(a) are submitted to be in error, and the Board is respectfully requested to reverse the rejections.

Respectfully submitted,

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Appendix

The claims on appeal as currently amended read as follows:

1. A rolling bearing in which at least one of an inner ring, an outer ring and a rolling element is formed of a steel material containing alloy ingredients each within a range of C:0.8 to 1.20% by weight, Si: 0.60% by weight or less, Mn: 0.25% by weight or less, Cr: 1.00 to 1.50% by weight and Mo: 0.60 to 1.50% by weight, then applied with hardening/tempering, the amount of residual austenite over the entire cross section of the one of the inner ring, the outer ring and the rolling element is 0% by volume and a surface hardness of the raceway surface of the inner and the outer ring and the rolling surface of the rolling element is HRC of 62 or more.

2. A rolling bearing in which at least one of an inner ring and an outer ring is formed of a steel material containing alloy ingredients each within a range of C:0.8 to 1.20% by weight, Si: 0.60% by weight or less, Mn: 0.25% by weight or less, Cr: 1.00 to 1.50% by weight and Mo: 0.60 to 1.50% by weight, then applied with hardening/tempering, the amount of residual austenite over the entire cross section of the one of the inner ring and the outer ring is 0% by volume and a surface hardness of the raceway surface of the inner and the outer ring is HRC of 62 or more, and in which a rolling element is formed of a steel material containing alloy ingredients each within a range of C:0.3 to 0.6% by weight, Si: 0.3 to 1.5% by weight, Mn: 0.3 to 1.7% by weight, Cr: 0.5 to 2.5% by weight and Mo: 0.6 to 3.0% by weight, with the O content being 9 ppm or less, applied with carbo-nitridation and then applied with hardening/tempering, the amount of residual austenite over the entire cross section of the rolling element is 0% by volume and a surface hardness of the rolling surface of the rolling element is HRC of 62 or more.

3. A rolling bearing in which at least one of an inner ring and an outer ring is formed of a steel material containing alloy ingredients each within a range of C:0.8 to 1.20% by weight, Si: 0.60% by weight or less, Mn: 0.25% by weight or less, Cr: 1.00 to 1.50% by weight and Mo: 0.60 to 1.50% by weight, then applied with hardening/tempering, the amount of residual austenite is 0% by volume and a surface hardness of the raceway surface of the inner and the outer ring is HRC of 62 or more, and in which the rolling element is formed of a martensitic steel, applied with hardening/tempering and then applied with nitridation to form a nitride layer at a thickness of 3 μm or more on the surface and then applied with finishing to a surface roughness of 0.1 μm Ra or less.

4. A rolling bearing in which at least one of an inner ring and an outer ring is formed of a steel material containing alloy ingredients each within a range of C:0.8 to 1.20% by weight, Si: 0.60% by weight or less, Mn: 0.25% by weight or less, Cr: 1.00 to 1.50% by weight and Mo: 0.60 to 1.50% by weight, then applied with hardening/tempering, the amount of residual austenite over the entire cross section of the one of the inner ring and the outer ring is 0% by volume and a surface hardness of the raceway surface of the inner and the outer ring is HRC of 62 or more, and in which a rolling element is formed of ceramics.

11. A rolling bearing in which at least one of an inner ring and an outer ring is formed of a steel material containing alloy ingredients each within a range of C:0.8 to 1.20% by weight, Si: 0.60% by weight or less, Mn: 0.25% by weight or less, Cr: 1.00 to 1.50% by weight and Mo: 0.60 to 1.50% by weight, then applied with hardening/tempering, the amount of residual austenite over the entire cross section of the one of the inner ring and the outer ring is 0% by volume and a surface hardness of

the raceway surface of the inner and the outer ring is HRC of 62 or more, and in which a rolling element is formed of a steel material containing alloy ingredients each within a range of C:0.3 to 0.6% by weight, Si: 0.3 to 1.5% by weight, Mn: 0.3 to 1.7% by weight, Cr: 0.5 to 2.5% by weight and Mo: 0.6 to 3.0% by weight, with the O content being of 9 ppm or less, applied with carbo-nitridation and then applied with hardening/tempering, the amount of residual austenite is 0% by volume and a surface hardness of the rolling surface of the rolling element is HRC of 62 or more.